

Final Evaluation Report

Your Details	
Full Name	Ugo Mendes Diniz
Project Title	Bats and flowers in a protected area of the Brazilian savanna: the structure of a mutualistic network surrounded by the urban and rural expansion
Application ID	28478-1
Grant Amount	£5223
Email Address	ugomdiniz@gmail.com
Date of this Report	13 th February 2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Sampling of bat community and diet				
Identifying main feeding sites and foraging range of bats in the site				The usage of radio transmitters to record bat movement was not possible. However, some information about species-specific preferred feeding habitats was obtained.
Diet and specialization of the endangered <i>Lonchophylla dekeyseri</i>				
Diet and specialization of the endangered <i>Lonchophylla bokermanni</i>				The species was not captured at the study site.
Effect of plant phenology of nectar bat diet				
Reconstruction of the interaction network between bats and plants				
Recording novel interactions between plants and nectar bats				

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

The project was mostly successful. Due to the COVID-19 pandemic, a few difficulties arose, namely the lack of institutional vehicles for fieldwork (due to a freeze in many of the university's institutional activities during the isolation period) and lack of field assistants. These were tackled by using some of the funds that were directed to other items/activities for a car rental service, and by extending the project by one semester so that all objectives could be achieved, both measures approved by Rufford.

The initial plan to register the foraging areas of endangered bats using radio transmitters was also not carried out due to the tight time schedule and due to some difficulties with getting the permits to use this method. The funds were redirected to other items and activities, such as the purchase of a microscope for pollen analysis and material for species barcoding, also approved by Rufford.

3. Briefly describe the three most important outcomes of your project.

- Network structure and drivers: We have reconstructed the network between flower-visiting bats and plants, and discovered a modular network separated by species functional groups. Specialized nectarivores (such as the endangered *Lonchophylla dekeyseri*) frequently visited tube-flowered species such as *Bauhinia* spp., while less specialized nectar bats visited open-flowered species more often. Frugivorous bats, which are opportunistic nectarivores, composed different functional groups within the network. Additionally, although species morphologies (rostrum and body size, and floral shape) separate groups in the network, pairwise interactions are defined by spatiotemporal patterns among the species.
- Keystone species and new interactions: We were able to define especially important species in the network, which sustain the nectarivorous bat community. Special highlights include the abundant and large-flowered *Caryocar brasiliense* and the mistletoe *Psittacanthus robustus*, a species with bird-pollinated flowers with no previous record of bat visitation, but which was strongly visited by bats.
- The diet of *Lonchophylla dekeyseri*: We have updated the diet of the endangered *L. dekeyseri*, which hasn't been thoroughly analysed for c. 20 years. The species feeds mostly on *Bauhinia* spp., which are found on forest edge sites. Therefore, *L. dekeyseri* was captured almost exclusively in forest edge sites, indicating a preference for this type of environment. It also restrains from visiting other keystone bat-pollinated species, such as *Caryocar brasiliensis*, which are typically found in typical cerrado (savanna) environments.

4. What do you consider to be the most significant achievement of this work?

5. Briefly describe the involvement of local communities and how they have benefitted from the project.

Not relevant.

6. Are there any plans to continue this work?

No, the objectives proposed were properly achieved, and there are no plans for an immediate continuation of the work.

7. How do you plan to share the results of your work with others?

Papers: Three research papers are planned to be published in international journals:

- "Changing the main course: strong bat visitation to the ornithophilous mistletoe *Psittacanthus robustus* (Loranthaceae) in a Neotropical savanna", currently accepted for publication in *Biotropica*.

- “Is morphological specialization a good predictor of interactions between plants and Neotropical flower-visiting bats?”, currently under review at Functional Ecology.
- “Spatiotemporal trends in nectarivores by bats in response to habitat structure and plant phenology in a Neotropical savanna”, currently in preparation for submission to Ecology and Evolution.

Conferences: In the timeframe between 2022 and 2024, I plan to present my results in conferences aimed at discussing tropical ecology (e.g., the annual meeting of the Association for Tropical Biology and Conservation) or aimed at mammalogy (e.g., Brazilian National Conference on Mammalogy).

One invited talk, titled “Bat pollination in the Cerrado: a valuable, unknown and threatened ecosystem service” has already been given to the II Forum of Undergraduate Teaching Students, Federal Institute of Piau , Brazil, in October 2020, and contained preliminary results from the project.

8. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

The grant was used over a period of 2 years, roughly from 1st August 2019 to 31st August 2021. Fieldwork was expected to last until September 2020, with the defence of the dissertation in February 2021. However, the project had to be extended by 6 months due to the Covid-19 pandemic. Although not planned, this extended period allowed for an additional sub-project that was not planned in the original project, namely the investigation of bat pollination in the ornithophilous *Psittacanthus robustus* and the dependence of bats on the species.

9. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in   sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
30x18 cm cotton bags, 100 units	101		-101	Donated/another source
Cotton gloves, 1 pair	1		-1	Donated/another source
CA 26749 Protection gloves, 1 pair	2		-2	Donated/another source
Precision forceps, 1 pair	4		-4	Donated/another source
1,5 mL neutral Eppendorfs, 500 units	5		-5	Donated/another source

Laboratory latic acid (Dinâmica), 500 mL	6	6		
Organizing box, 2 units	7		-7	Not necessary
30L thermal container, 1 unit	7		-7	Not necessary
N° 15 scalpel blades, 100 units	8		-8	Donated/another source
Microscope slide container, 6 units	14	20	+6	
Laboratory crystal phenol, 500 g	8	7	-1	
Safranin O solution, 1 L	8	8		
Laboratory glycerine, 1 L	10	8	-2	
24x50 mm Laminules for microscopy, 1000 units	12	14	+2	
100 m glass fibre measuring tape	13		-13	Donated/another source
Ultra-pure powdered neutral gelatine, 1000g	32	10	-22	
Petzl Tikkina head lantern (150 lm)	69		-69	Donated/another source
Food (12 census months)	365	376	+11	
Fuel for transportation inside the park (12 census months)	670	696	+26	
1014/12 12x2.5 m mist nets (Ecotone), 9 units	519		-519	Donated/another source
2.5x4 mm aluminum bands (Capri), 1000 units	325	305	-20	
6x5 mm aluminum bands (Capri), 1000 units	483		-483	Not necessary
LB-2P/BD-2P VHF radio-transmitters (Holohil Systems Canada), 15 units	2554		-2554	Cancelled
Sub-total	5223	1450	-3773	
Professional microscope with HD CMOS 1080p camera		1700	+1700	Item added afterward with approval from Rufford
Car rental service		1138	+1138	Approved afterward
Ultra-pure water (100 mL)		125	+125	Approved afterward
dNTP solution (1 mL)		171	+1171	Approved afterward
200 microl pipette tips (1000 units)		3	+3	Approved afterward
Cyber Safe colouring agent (400 microl)		78	+78	Approved afterward
1000 microl pipette tips (1000 units)		3	+3	Approved afterward

DNase free eppendorfs (500 units)		15	+15	Approved afterward
PBS buffer (500ml)		47	+24	Approved afterward
Ladder solution (500 uL)		48	+48	Approved afterward
TAQ polymerase kit (1 unit)		42	+25	Approved afterward
PCR well plaque (1 unit)		42	+42	Approved afterward
Polypropylene sealing film (100 units)		58	+36	Approved afterward
Sequencing service (Catholic University of Brasília)				Approved afterward. Not executed within the timeframe of the project
Agarose gel (100g)				Approved afterward. Donated
FINATEC 10% refund fee		494	+494	
TOTAL	5223	5414	+191	

*Exchange rate used to calculate the Actual Amount as established in the initial project (0.20 BRL/GBP). Therefore, actual values may have an error margin.

10. Looking ahead, what do you feel are the important next steps?

Having found some patterns and mechanisms behind the interaction networks, some next important steps include:

- Exploring deeper the ecological and evolutionary mechanisms behind the *Lonchophylla-Bauhinia* relationship, specifically what leads to such tight relationship and the preference for forest edges as habitats. As a main resource for the species, understanding the drivers of the strong interaction with *Bauhinia* spp. is a crucial step towards its conservation.
- Carrying on with the radio-tracking of nectarivorous bats, which was unfortunately not possible within the timeframe of this project. We found that bats with the study area are fairly segregated into preferred foraging zones. Exploring the flight routes and foraging behaviour of bats is key to understanding how this segregation occurs.
- Finishing the sequencing of bat specimens captured in the site, which will be performed by our group in the following months. Several tissue samples were collected from bats, many of which were not clearly identified. Carrying out the barcoding of these specimens may reveal new species records for the site.
- As nearly all bats were tagged, the monitoring of populations in the area can be carried out in future expeditions to the area. This is especially important for *L. dekeyseri*, which is currently suffering from fragmented subpopulations and overall populational decline.

11. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The Rufford Foundation logo was used in digital presentations related to the project, namely: (i) the public dissertation defence of the grand receiver at the University of Brasília, Brazil, (ii) a project presentation to the Plant-Insect Interactions research group at the Technical University of Munich, Germany, and (iii) a talk given to undergraduate students at the Federal Institute of Piauí, Brazil, about bat pollination that summed up some results of the project. The Rufford Foundation did not receive publicity during the course of the work.

12. Please provide a full list of all the members of your team and briefly what was their role in the project.

Ugo Mendes Diniz: Project head and grant recipient.

Prof. Dr. Ludmilla Moura de Souza Aguiar: Project supervisor.

Nina Luiza de Sá Fischer: Field assistant and co-author of the *Psittacanthus robustus* sub-project.

Guilherme Dantas Grigório: Recurring field assistant, currently using some of the material collected by this project for his undergraduate research.

Igor Daniel Bueno Rocha: Recurring field assistant. Advisor for genetical procedures.

Priscilla Braga Petrazzini: Recurring field assistant.

Lucas Lauretto: Recurring field assistant

Anna Carolina Faria Pinto (FINATEC): Funds management.

Carlos César Correia dos Santos (FINATEC): Funds management.

Daniela de Araújo Rezende Rocha (FINATEC): Funds management.

Several other (ca. 50) undergraduate or graduate students from the University of Brasília participated as infrequent field assistants.

13. Any other comments?

We members of the project deeply appreciate the initiative of The Rufford Foundation and are thankful for the grant. This project was only possible due to it, and as Brazilian scientists, which are continuously struggling with a lack of funding and infrastructure, we highlight how important these grants are for early-career researchers in countries from the Global South.